GRAVITY BASED ON BOHMIAN TRAJECTORY CURVATURE

by

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Summary. Deflection angles attributed to light from 18 stars, at 2.433 to 4.817 solar radii from the sun, obtained by Bruns (2018) during the 2017 total eclipse, exhibited a 0.91correlation with gravity derived angles, on allowance for a 5 per cent software correction. Observed and derived deflection angles additionally shared a negative linear dependence on solar distance. Extension of the analysis to single photon trajectory curvature, by gravity, drew on the success of averaging over weak momentum measurements in reconstruction of the Bohmian trajectory of single photons in self-interference.

The search for a quantum-scale theory of gravity presupposes occurrence of a geodesic and a resolution of the 'which-way' problem in the transition between quantum states (Feynman, 1965). Averaging over weak measurements of momentum (Aharanov, Alberts and Altman, 1988), Kocsis et al. (2011) succeeded in reconstructing photon trajectories during self-interference. Trajectory density peaks obtained were subsequently revealed to exhibit a 0.99 correlation with spectrum intensity peaks, at a risk of error placed between 5 to 6 standard deviations (Davis, 2017). Weak measurements (Aharanov, Alberts and Altman, 1988; Wiseman, 2007; Davidovic et al., 2013) thus opened the way to circumvent path uncertainty, formalized by Heisenberg (1927), and thus resolved the long-standing 'which-way' problem in quantum mechanics.

A strong correlation between peaks in photon trajectory density and self-interference maxima (Kocsis et al., 2011; Davidovic et al., 2013; Davis, 2017) furnished an approach to formulating a macroscopic model of quantum-scale events. Accordingly, the deflection of star-light, during a solar eclipse, may be seen as the action of gravity in curving the trajectory of each photon. In this connection, Bruns (2018) furnished light deflection observations on 18 stars, at distances between 2.433 to 4.817 solar radii, during the August, 2017 total eclipse.

All deflections were determined with AST (Astrometrica), or MDL (Diffraction Ltd.) software. Both sets of angles, listed in Table 1, show close agreement, resulting in a correlation coefficient, $r = 0.95$. Light close to the sun exhibits an elevated deflection angle, θ, attributed to the strength of gravity. The angles obtained were matched with those attributed to gravity, based on the following expression (Lewin, 2008)

$$\theta = \frac{4GM}{\ell c^2}$$

ℓ denotes distance to the sun, G is the gravitational constant, M specifies sun mass, while c signifies light velocity. The coefficient, 4, corresponds to the number of Minkowski space-time dimensions. Deflection angles, on conversion from radians to arcsec, derived with the above relation, exhibited a 0.86 correlation coefficient, r, with AST and MDL determined deflections (Table 1). Taking into account the 0.05 mismatch between both software evaluations, gravity accounted for 91 per cent ((0.86/0.95) x 100) of the corroborated deflection observed by Bruns (2018), during the 2017 solar eclipse.

Table 1. Light deflection at specified distances in the 2017 solar eclipse

Solar radii	Distance	Light Deflection			
		MDL	AST	Derived	
N	km ($\times 10^5$)	arcsec	arcsec	rad. ($\times 10^{-6}$)	arcsec
2.433	16.926	0.786	0.728	3.519	0.726
2.446	17.017	0.666	0.641	3.50	0.722
2.694	18.742	0.664	0.635	3.178	0.655
3.0	20.871	0.538	0.538	2.854	0.590
3.058	21.275	0.585	0.582	2.799	0.577
3.168	22.040	0.584	0.606	2.702	0.577
3.306	22.10	0.502	0.506	2.589	0.534
3.395	23.619	0.491	0.524	2.522	0.520
3.555	24.732	0.344	0.326	2.408	0.497
3.649	25.386	0.507	0.511	2.346	0.484
3.676	25.574	0.469	0.497	2.329	0.480
3.694	25.699	0.537	0.511	2.317	0.478
3.76	26.158	0.406	0.316	2.277	0.470
3.802	26.451	0.547	0.552	2.252	0.464
3.828	26.631	0.354	0.358	2.236	0.461
4.522	31.406	0.329	0.270	1.893	0.391
4.566	31.766	0.45	0.408	1.875	0.387
4.817	33.512	0.369	0.242	1.777	0.367

r(MDL/AST) = 0.95, r(derived/MDL) = 0.86, r(derived/AST) = 0.86

Analysis of light deflection at different solar distances, ℓ, obtained with MDL and AST software, and the gravity relation led to comparable linear relations

$\theta(\mathrm{MDL}) = 1.034 - 0.021\,\ell$ ($r^2 = 0.67$).

$\theta(\mathrm{AST}) = 1.096 - 0.024\,\ell$ ($r^2 = 0.73$)

$\theta(\mathrm{derived}) = 1.051 - 0.021\,\ell$ ($r^2 = 0.95$)

The decrease in star light deflection with solar distance is, thereby, directly linked to a decrease in gravity. This relation evidently extends to each photon trajectory. Single photon trajectories reconstructed by averaging over weak measurements of momentum (Kocsis et al., 2011) were, in this connection, demonstrated to form a density distribution that closely matched the self-interference spectrum (Davis, 2017). Visible star light wave-lengths, λ, span 400 to 700 nm, where

$\lambda = h/p$

photon momentum, p. and Planck's constant, h, determine each wave-length. In quantum processes at scales remote from Planck units of space and time, curvature of the Bohmian trajectory is seen to serve as a measure of gravity.

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